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DEPARTMENT OF STATE

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DEF 1-4 NORAD

Dr. George LINDSAY of the Defence Research Board testified on May 21 before the House of Commons Committee on External Affairs and National Defence on the implications for Canada of the Safeguard ABM system. Lindsay's testimony on the 21st was a continuation, and termination, of his presentation entitled "Strategic Weapons, Stability, and the Possible Contributions by Canada", which he began on May 13 (refair). A copy of Lindsay's presentation of May 21 is enclosed.

Lindsay said that there are three possible types of ABM systems, depending on whether the ICBM is to be destroyed in the launch phase, in mid-course, or in the terminal phase of its trajectory. If a mid-course interception system were designed, it would seem that many of the installations would be most effective if located in Canada, Lindsay said. Lindsay pointed out, however, that the Safeguard system is a system designed to intercept ICBM's near the terminus of their intended trajectory. In such a system, he said, the ABM missiles are sited in the general vicinity of the expected targets, and analysis done in Canada indicates that little would be gained for the defense of U.S. targets by siting missile batteries much to the north of the zones to be defended. In the case of Perimeter Acquisition Radars (PAR's), however, some advantage would be gained by siting them in Canada. At any rate, Lindsay said, no U.S. requirement for missile or

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radar sites in Canada has arisen. Lindsay said that the Safeguard system could not function unless the northern Spartan batteries make their interception over Canada; whether their altitude puts the missiles above the legal limit of national airspace is a question for space lawyers. Lindsay added that it is quite possible to deploy an ABM system which employs a short-range missile with a range less than that of Sprint; such missiles would not have to intercept over Canada.

Lindsay gave a detailed presentation of the risks to life and property in Canada which might result from interceptions of Soviet ICBM's over Canada. Lindsay said that Spartan bursts would occur at least 25 miles above a city and damage would be minor. He said that it is not yet known whether Sprints will be close enough to the border for them to burst above Canadian territory. Similarly, Lindsay pointed out, the fallout from a Spartan burst would be negligible; the greatest fallout hazard for Canada would be from an ICBM ground burst in the northern U.S.

Lindsay said that the ability of the full Safeguard system to extend its limited protection to major Canadian centers of population is not certain and would depend among other things on the exact locations selected for PAR's and Spartans. He concluded by saying that it is too soon to forecast what the U.S. view will be regarding the relationship between NORAD and Safeguard, quite apart from whether Canada does or does not elect to participate in any aspect of active ballistic missile defense.

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STRATEGIC WEAPON SYSTEMS, STABILITY,
AND THE POSSIBLE CONTRIBUTIONS BY CANADA

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PART III: THE IMPLICATIONS FOR
CANADA OF BALLISTIC MISSILE DEFENCE

The most basic implications for Canada regarding defence against ballistic missiles are the same as for the rest of the world - that is, the preservation of stability and the resultant prevention of nuclear war. However, because of our geographical position on the direct great-circle route between the two Super-powers, and sharing a long border with one of them, we are concerned with the problem in a very special way.

The Significance of Canadian Geography
for BM Defence of the USA

In the previous section, it was demonstrated that Canadian geography has a vital significance for the defence of the United States against attack by bomber aircraft. In fact, it would be impossible for the US to create an effective defence system without the use of Canadian airspace, and very inefficient to attempt to do so without the basing of radars, air bases, and/or missile sites in Canada. Comparable questions arise for ABM defence. If the US wishes to defend her own territory against ballistic missile attack, must she launch defensive missiles over Canadian territory? Must she base ABM installations in Canada? Further questions which can also be asked of anti-bomber defence include: is it possible for a system sited for the defence of targets in the USA to give any protection to targets in Canada, and, also, what are the risks to the people and property on the ground beneath the interception?

As with air defence, the problem begins with early warning. The earliest warning that can be obtained of the approach of an ICBM is the detection of the launching. Since tremendous energy is released by the booster rockets, sensitive instruments may be able to detect this at very long range. However, generally speaking, the closer they are to the launch site, the better the

detection. Canadian territory does not offer any unique attraction for the location of such sensors.

Once the booster rockets have burned out, the main means of detection or tracking is by radar. The Ballistic Missile Early Warning System (BMEWS) depends on three large radar stations in Alaska, Greenland, and England. In general, the best locations will be close to the likely ICBM trajectories, so, since Canada lies under most of the probable trajectories, her territory could be valuable for the location of future warning and tracking radars.

Many types of active ballistic missile defence systems have been conceived. They fall into three categories, depending on whether the ICBM is destroyed in the launch phase, in mid-course, or in the terminal phase of its trajectory.

Canadian territory is too far away to enable a land-based weapon to intercept an ICBM launched from the Soviet Union before its booster rockets have burned out (i.e. during the launch phase).

If a mid-course interception system were designed, it is probable that Canadian geography would be very important. Some of the tracking and control radars and the anti-missile missiles might be in ships or aircraft, but since the middle portion of the trajectories cross over Canada, it would seem that many of the installations would be most effective if located in our territory.

If radars (or other sensors) are needed for the close examination of objects on ballistic trajectories, for discrimination of decoys, for accurate determination of trajectories, or for tracking during and after a manoeuvre, it is quite conceivable that sites in Canada would be advantageous. It is also possible that problems of nuclear blackout could make it desirable to have a widely based system of sensors. However, no requirement for sites in Canada has arisen to date with regard to active defence

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against ballistic missiles.

For both peaceful and military purposes, it is necessary to maintain detection, tracking, and surveillance of objects orbiting in space. Since polar orbits are concentrated on the northern latitudes, Canadian territory could have a particular value. The optical tracking camera at Cold Lake, Alberta, is used in this role. Such instruments serve useful purposes for scientific and commercial satellites, in co-operation with communication relays and telemetry stations.

In an active defence system intercepting ballistic missiles near the terminus of their intended trajectory, the anti-missile batteries will be sited in the general vicinity of the protected targets. Safeguard is such a system, as was its predecessor Sentinel. In neither case was there a request from the US for permission to locate installations north of the border. Analysis done in Canada indicates that little would be gained for defence of targets in the USA by siting missile batteries much to the north of the zones to be defended. It is possible that some advantage would be gained by placing some Perimeter Acquisition Radars (PARs) north of the border, especially if Safeguard is to have a capability to intercept missiles approaching on the low trajectories of the Fractional Orbital Bombardment System (FOBS) or Depressed Trajectory ICBM.

As regards the firing of defensive missiles over Canada and the bursting of defensive warheads above Canadian territory, the position of the more northerly targets in the US (such as the Minuteman complexes to be defended by the first phase of Safeguard) and the long range of the Spartan anti-missile missile make it very evident that the system cannot function unless anti-missile missiles launched from the northern Spartan batteries make their interception over Canada. Whether their altitude puts the missiles above the legal limit of national airspace, and into international outer space, is a question for space

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lawyers, but it should be remembered that they will only be fired as a defence against overflight by ICBMs launched across Canada with destructive intent.

The requirement to fire over Canada in defence of targets in the northern USA will apply to other long-range anti-missile missiles like Spartan. Sprint has a much shorter range, and it is quite possible that a terminal defence system specifically designed for the sole purpose of protecting small hard targets (such as Minuteman) would employ an interceptor with a range less than Sprint. Except for defence of targets within a very few miles of the border, such missiles would not have to intercept over Canada.

Risks to Life and Property from ABM

The next question to discuss is the physical risk to persons and property on the ground, whether Canadian or American. It has been mentioned that the Spartan has a very large thermo-nuclear warhead. The mechanism by which it destroys the effectiveness of the approaching ICBM functions best in the near-vacuum of outer space, and the intention of the system is to perform the interception far above the dense atmosphere.

Our calculations indicate that if a warhead of the general size of a Spartan were to burst 25 miles above a city, there could be some light damage to property from blast (broken windows) and, if the weather were clear, it is possible that fires could be started in tinder-like material and that the exposed skin of persons outside in the open could receive burns. These effects become very much more serious for bursts at lower altitude; indeed, it is probable that an attacker who wished to produce maximum casualties and damage to a city would fuse his ICBM warhead to burst no more than a few miles above the centre of the city, achieving most of his damage through blast and fire.

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However, the same effects become much weaker for bursts above the 25 mile altitude, and it is understood that all detonations of Spartan will be well above 25 miles.

If the weather is clear, a large nuclear detonation, even at high altitude, can pose a hazard to vision. If a person were outdoors when the detonation occurred, he would suffer a temporary flash blindness rather like snow blindness. If he were unfortunate enough to be looking in the general direction of the burst at the precise instant that it detonated, he could suffer some permanent but partial impairment of vision.

A Spartan burst would not produce a dangerous radioactive hazard on the ground. If all the megatons in all the Spartans in the full Safeguard deployment (12 sites) were detonated at their high operational altitude, the resulting radioactivity would be widely distributed through the stratosphere. Almost all of it would decay before eventually settling to earth. The increase to the general background level of radioactivity on the surface of the earth would be much less than that caused by the approximately 400 nuclear explosions that have been let off above ground prior to 1968, and far below the tolerance levels agreed for industrial safety.

The other anti-missile missile, Sprint, has a very much smaller warhead than Spartan, and can, therefore, be used at much lower altitudes without inflicting serious damage on the ground. Like Spartan, it poses no significant danger of fallout. It is not yet known whether Sprints in the Safeguard plan will be close enough to the border for them to burst above Canadian territory.

Risks to Life and Property from ICBMs

One should not wax too indignant over the hazards inflicted by defensive ABM weapons without contemplating the effects of the offensive ICBM if it should succeed in its intended

mission. If its target is a city, or an airfield, it may be fused for an airburst or a groundburst. The airburst produces a greater total area of damage to buildings of low resistance or to other comparatively soft structures (such as aircraft), and will not cause serious radioactive fallout.

If the target of the ICBM is a hardened missile silo or underground control centre, the probability of destruction may be increased by using a groundburst, since nothing can survive in the crater, and the shock transmitted through the earth might seriously damage underground installations.

A groundburst may produce heavy radioactive fallout, not only in the vicinity of the target but over very large areas downwind of the burst. The degree of radioactive contamination depends on the composition as well as the size of the nuclear weapon. The smaller weapons depend on fission, and it is the fission products which are strongly radioactive. Large weapons require fission to trigger them, but may achieve most of the energy release through fusion. If the proportion of fission is small, the bomb is described as "clean", and produces relatively little radioactive fallout even with a groundburst.

The possibility of serious "worldwide" fallout (as dramatized by novelists) would only exist if a very heavy attack were made using groundbursts with large "dirty" bombs. This could have unpleasant consequences for the attacker as well as the recipient, and is, therefore, unlikely to happen. Nevertheless, an attack aimed at hardened ICBM silos and underground control centres could well involve hundreds of ground bursts, and even if the weapons were "clean", the fallout within an area of many hundreds of miles from the weapon bursts could be very serious to human life.

All this has a very real significance for Canada. Depending on the political situation and the strategy selected by

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the USSR, Canadian cities and military installations might or might not be included as targets. To pave the way for bomber penetration, air defence installations will be targeted. In addition, if the objective is to cripple their major opponent, *it is difficult to believe that the Soviets would leave a friendly neighbour with an undamaged economy available to help in the rehabilitation of the USA.*

The nature of fallout caused by groundburst nuclear weapons, and the geography and meteorology of North America, are such that a series of groundbursts in the northern half of the USA, particularly in the area of the Minuteman bases, is likely to produce heavy fallout in Canada. Consequently, even if Canada were fortunate enough to escape the impact of nuclear weapons on her own territory, she might still have to face the hazards of radioactive fallout due to nuclear weapons burst in the USA.

It may be possible that the result of detonating an anti-missile missile close to an incoming ICBM could be to make the ICBM detonate too. The designers of the ABM warhead intend that the defensive burst will damage the ICBM in such a way that its warhead will not produce a nuclear explosion, and this is most likely what will happen. However, it is believed in some quarters that the designers of the ICBM warhead can and will fit a special fuse causing it to detonate on the first receipt of radiation from the defensive explosion. Without judging the merits of this argument, it will nevertheless be true that, in every case, the total damage to North America would be less than would have been suffered if the ICBM had burst where its owners had intended.

To summarize, the significant risks come from the offensive ICBM (or SLBM) and not the defensive ABM. If ABM prevents an ICBM from bursting at its intended point, both lives and resources have been saved; if it prevents it from bursting on the ground, then the radioactive hazard has been decreased, to Canada as well

as the USA, even if the targets were all south of the border.

Potential Protection for Canadian Targets

Although the Spartan anti missile missile has a range of about 400 miles, it should not be concluded that it can protect every target within a circle of 400 miles radius centred on the missile site, and no target outside of that circle. The volume into which a Spartan can reach and intercept has the shape of an open umbrella, with the handle on the Spartan site, the stem vertical, and the rim some distance above the ground because of the need to limit the height of burst to a safe and effective altitude. The incoming ICBMs approach at a low angle (typically in the vicinity of 20-25 degrees from the horizontal for ranges of 5000-6000 miles). If one thinks of a shower of ICBMs as raindrops, driven nearly horizontal by a strong wind, it can be seen that the umbrella will be able to keep an area on the ground dry which is not circular but oval, elongated in the down-wind direction, and with its centre down-wind of the battery site.

This "dry zone" is known as the "protected footprint". Its exact shape depends on the horizontal direction and the angle of descent of the ICBM, being shorter for the steeper trajectories. If the PAR makes an early detection of the incoming ICBM, establishes a track without undue delay and transfers the data to the Missile Site Radar (MSR), and if the decision to engage that ICBM from that Spartan site is taken promptly, then it may be possible to launch the Spartan in time to make the interception at its maximum range (on the surface of the "umbrella"). Otherwise, the radius of the umbrella and the size of the "dry zone" or footprint will be reduced.

A similar geometry on a reduced scale describes the protection afforded by the shorter range Sprint anti-missile missile.

If the USA deploys the full Safeguard system to give light area protection to all of the country, there would be five sites along the northern border, each equipped with PAR, MSR, and Spartan and Sprint. The approximate locations have been listed as:

Great Falls, Montana
Grand Forks, North Dakota
"Upper Northwest" (Washington State)
Michigan/Ohio Area
Southern New England

It is understood that the sites will not be close to large cities. Therefore, the purpose of the Sprints will be to defend the PAR, MSR, Spartan battery, and whatever ICBM and bomber installations are close enough. Thus, no Canadian protection can be expected from the Sprints of the Safeguard system. On the other hand, the protected footprints of the five Spartan batteries, plus the seven others that make up the full deployment, will cover all 48 states, providing protection to the American population against a light attack (from China), or from an accidental launching from any source.

A natural question to ask is whether it will be possible for these Spartan batteries to provide protection for Canadian population. Or, put another way, how many Canadians will live inside the "protected footprints" of the five northern Spartan batteries?

This question cannot be answered in detail without more precise knowledge of the performance of the components of the system, and of the location of the sites. Even with this information, it would still be necessary to postulate the exact trajectories that the attacking ICBMs would follow. However, by making estimates of all these factors, it is possible to state that Montreal and Toronto appear to be in a fringe area such that

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they could be defended against some but not all of the most probable trajectories. If the attacker had the same information, and if he elected to attack these cities, he would presumably choose one of the trajectories least favourable to the defence. *The degree of protection available to these two cities depends* in a sensitive way on the exact position of the PAR/Spartan sites. The same relationship probably applies to many other of the larger Canadian cities, implying that a considerably increased protection could be given to them by moving PAR and/or Spartan sites to more northerly locations in the USA. There are, however, Canadian cities (such as Edmonton and St. Johns, Newfoundland) which are too far from the border to be protected from Spartan type installations in the USA.

It must be emphasized that such factors only determine whether it would be physically possible for ICBMs aimed at Canadian targets to be intercepted by Spartans sited in particular places. If it were physically possible, it would still have to be arranged in the firing doctrine and computer programming that the interceptions would, in fact, be attempted.

The question of potential protection for Canadian population has been discussed in terms of the planned deployment of Safeguard. However, even the full deployment (of 12 sites) can give no more than a thin degree of protection to American cities, which could be significant against a light or accidental attack but would be overwhelmed by a heavy attack. For this or other reasons, Canada may not wish to request protection for her population by Safeguard. Nevertheless, should strategic developments cause the USA to deploy a thick ABM system for defence of population against a heavy attack at some time in the future, it is probable that the capability of such a system to provide a comparable degree of protection to Canadian population would be governed by much the same factors as have been described for Safeguard.

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ABM and NORAD

An important instrument for practical defence co-operation in North America is the NORAD Agreement. The mission of NORAD is defence against air attack, but its responsibilities include warning against missile and space attack as well. In the Agreement renewing NORAD for five years to 1973, it is stated "that this Agreement will not involve in any way a Canadian commitment to participate in an active ballistic missile defence".

From a strategic point of view, anti-bomber and anti-missile defence are part of a single problem. To determine whether North America is being threatened, or should alter its state of alert, many types of information are wanted, and should be assessed as a whole rather than piecemeal. Strategic decisions and operations are most effectively handled as a single aerospace activity.

NORAD receives information concerning missile and space activity from many sources. ICBMs approaching over the polar regions would be detected by the BMEWS. This consists of large detection and tracking radars in Alaska, Greenland, and England, whose information is relayed to the computers in the NORAD Combat Centre. Many of the communications circuits come through Canada. Processed warning information is passed on to other organizations such as the National Military Command Centre in Washington, National Defence HQ in Ottawa, the US Strategic Air Command, and Supreme HQ Allied Powers, Europe. Radars at air defence sites on both coasts of the USA have been modified to enable detection and warning to be given if SLBMs were to appear.

In order to be able to give warning against attack from space, NORAD operates a Space Detection and Tracking System (SPADATS) with a variety of sensors in many locations. A Canadian contribution is the Baker-Nunn optical camera at Cold Lake, Alberta. The reports of objects in space are catalogued

by computers in the NORAD Space Defence Centre, which continually updates the information on orbiting satellites, spent booster tankage, and other objects. By watching these, it is possible to detect manoeuvres or disappearances, predict re-entry, and identify the appearance of new objects.

Thus, NORAD can detect, identify, and give warning of ICBM and SLBM attack against North America, and can observe the movements of objects orbiting in space. But it cannot intercept or destroy ballistic missiles.

To carry out its mission of defence of the North American continent against air attack, NORAD conducts the operational control of the air defence forces such as radar stations, interceptor squadrons, and surface-to-air missile batteries. Some of these are located in Canada, some in the USA. Some are manned by Canadians, some by Americans. Some are financed by Canada, some by the USA. Certain weapon systems (such as the Hercules surface-to-air missiles) are entirely American in location, manning, and financing, but come, nevertheless, under the operational control of NORAD.

If Safeguard or some other ABM system is deployed in North America, arrangements will have to be made for its operational control. Also, the information necessary in order to assess the overall strategic situation and make the major strategic decisions regarding aerospace defence must be provided. The necessary type of information is very much the same as that already collected by NORAD today, but five years hence there would probably be additional sources from new systems of missile detection and space surveillance.

Many of the tactical decisions made in air defence depend on the assessments by experienced officers of a situation presented to them by the communication and display system. Although they have to make their decisions quickly, the speed of human reaction

supported by the SAGE computer is sufficient to permit identification and interceptions to be made. The approaching aircraft are unlikely to be moving faster than about 10 miles a minute.

The more detailed command and control of the units of an ABM system are likely to be somewhat different in character from that for air defence units. ICBMs will approach at speeds above 250 miles a minute. There is an opportunity, in principle at least, to allot defensive weapons to attackers with full knowledge of the intended targets, since the future trajectory of a ballistic missile can be predicted (unlike that of a bomber). Because many of the characteristics and tactics of the ICBMs attack are not known, but must be assumed in order to make the decisions regarding defence, it will be desirable to correct inaccurate assumptions as soon as they are perceived, and make the improved information available to the entire defence system very quickly indeed.

The only way to handle such a problem is by a very considerable extension of the role of computers. Practically all of the operational control of the weapons will have to be performed by computer, following instructions programmed into them long before the battle is joined. The main decisions will be taken when the computer programs are designed, although further decision will probably be required prior to and during the battle.

From the Canadian point of view, it can be said that NORAD has proven to be an efficient and satisfactory means of handling the collection, evaluation, and dissemination of information regarding aerospace activity, and the operational control of active air defence. It has served, in addition, as a convenient and useful channel for the exchange of technical and planning information between the two partners.

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However, if ABM becomes a reality, it may or may not prove desirable to place its operational control under NORAD, quite aside from considerations of Canadian participation. At the present time, the US has not decided how the operational control of Safeguard will be organized, and it does not appear that a decision is a matter of urgency.

Summary

In order for the Safeguard system to defend targets in the northern United States, it will be necessary for them to intercept ICBMs above Canadian territory. This will likely be true for any future ABM systems employing long-range anti-missile missiles.

The effects on persons or property on the ground due to interception by Spartans or Sprints will be negligible in comparison to the effects of ICBMs or SLBMs which reach their targets. In addition, the successful operation of an ABM system would reduce the risks from fallout for all the inhabitants of North America.

The ability of the full Safeguard system to extend its limited protection to major Canadian centres of population is not certain, and would depend among other things on the exact locations selected for PARs and Spartans. The same would likely apply to future ABM systems designed to protect US population.

NORAD is very effective for the processing of intelligence information regarding the aerospace threat, and the operational control of the forces for anti-bomber defence, and has also proven to be a useful channel for technical information and planning between Canada and the USA. It is too soon to forecast what the US view will be regarding the relationship between NORAD and Safeguard, quite apart from whether Canada does or does not elect to participate in any aspect of active ballistic missile defence.

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